DOCUMENT RESUME

ED 344 730 SE 051 969

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TITLE Some Factors Influencing Performance in a Psychological Statistics Course.
PUB DATE 90
NOTE 11p.
PUB TYPE Reports - Research/Technical (143) -- Speeches/Conference Papers (150)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Cognitive Processes; *College Mathematics; Higher Education; Homework; Introductory Courses; *Mathematics Achievement; Mathematics Education; *Motivation; Pretests Posttests; Prior Learning; Social Influences; *Statistics; Student Motivation; *Thinking Skills

ABSTRACT

The two purposes of this study were: (1) to determine the extent to which previous knowledge, on-going motivation and current social support influence performance in a college introductory statistics courses; and (2) to identify the thought processes used in statistics learning by students who preform well and perform well and poorly, respectively, in the course. The subjects were all 30 students enrolled in an introductory statistics course required for psychology majors. They were assessed in the following ways: a single pretest covering arithmetic and algebraic skills; a weekly questionnaire dealing with in-class friendships and study habits; bi-weekly laboratory sessions for statistics learning, using "think aloud" procedures; weekly homework assignments for which the answers were in back of the book; and midterm and final examinations. The pretest and homework performance accounted for 64% of the variance in examination scores. The 8 best and 8 worst examination performers showed similar thought processes in the laboratory. The results also suggest that previous mathematics ability may have motivational effects. Students with higher mathematical ability attend class more often, spend less time doing homework, and work more quickly and accurately than students with low ability. (KR)

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Some Factors Influencing Performance in a Psychological Statistics Course

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Abstract

The subjects were all 30 students enrolled in an introductory statistics course required for psychology majors. They were assessed in the following ways: a single pretest covering arithmetic and algebraic skills; a weekly questionnaire dealing with in-class friendships and study habits; bi-weekly laboratory sessions for statistics learning, using "think aloud" precedures; weekly homework assignments for which the answers were in the back of the book; and midterm and final examinations. The pretest and homework performance accounted for 64% of the variance in examination scores. The 8 best and 8 worst examination performers showed similar thought processes in the laboratory.

Some Factors Influencing Performance
in a Psychological Statistics Course

There are two major sets of purposes to this study: to determine the extent to which previous knowledge, on-going motivation and current social support influence performance in a college introductory statistics course; and to identify the thought processes used in statistics learning by students who perform well and poorly, respectively, in this course.

The extent of previous knowledge was assessed by a pretest which evaluated the student's statistically relevant knowledge. Our measure of motivation reflects a student's ongoing involvement and commitment toward achievement of course goals as determined by class attendance and the timely and accurate completion of assigned homework. We assessed the influence of social support through the use of a questionnaire designed to measure the number of friendships existing within the classroom and students' study involvement with other class members. Finally, thought processes were measured by bringing students into a laboratory setting to learn new statistics material and to "think aloud" while reading and solving problems.

This study is unique in several ways. First, we measured motivation throughout the course rather than at the beginning of the quarter. Motivation measured prior to course enrollment has been shown to predict test scores, e.g., Ames and Ames (1984), Lehrer and Hieronymus (1977). However, we have been unable to find studies dealing with concurrent motivation as related to class performance.

Second, we examined the influences of social support within the classroom as opposed to outside the educational arena, e.g., Edge and Friedberg (1984), and Welch, Anderson, and Harris (1982) have shown that familial and demographic variables influence academic performance. And finally, we looked at thought processes in the laboratory as a way to predict classroom performance. Other researchers such as Allwood (1984) and Chi, Bassok, Lewis, Reimann and Glaser (1989) have related thought processes in the laboratory for good and poor problem solvers to concurrent performance in the laboratory.

Method

Subjects and Procedure

The subjects were all 30 students enrolled in an introductory statistics class required for psychology majors lasting 10 weeks. On the first day of class a test was given to assess arithmetic and algebraic skills relevant to the course. The students were required to attend individual bi-weekly videotaped tutoring sessions to read and learn statistics material (Sessions 1 and 3) and to solve statistics problems (Sessions 2 and 4). A "think aloud" procedure was employed during these sessions. Unfortunately, the audio tracks for Sessions 3 and 4 were lost due to equipment malfunction.

Questionnaire and Homework

A seven item questionnaire was distributed to each student every week. The questions dealt with in-class friendships, self-confidence

in test performance, expected grade, studying time, and studying with classmates. Homework was assigned each week. The answers to all problems were given in the back of the book, and homework performance counted as one-third of the final grade (The midterm and final examinations counted one-third each).

Scoring the Tutoring Sessions

All the statements students made during Tutoring Sessions 1 and 2 were transcribed. For Session 1, (reading new material) eleven categories were constructed to initially code the statements. In part, these categories were based on those used by Chi et al (1989), and partly by empirical examination of the transcripts. The pairwise reliabilities of the categories were all greater than .80. These codes were subsequently grouped into three broader response categories: passive attempts to understand the material; active attempts; statements reflecting uncertainty. For Session 2 (solving percentile and percentile rank problems) six category codes were constructed. These categories were determined empirically by examining the transcripts and had pairwise reliabilities greater than .80. These codes dealt with how correctly students used a tabled frequency distribution, whether they confused formulas for percentiles and percentile rank, and how many items in the formulas were correctly solved. Additionally, the number of problems correctly solved in Sessions 2 and 4 were scored.

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RESULTS

Two sets of analyses are presented: intercorrelations of variables for all students in the class; and a comparison of the eight students receiving the highest average examination scores with the eight receiving the lowest, on performance during the tutoring sessions.

Significant Intercorrelations. The average examination score was positively related to students' pretest performance ($r = .55$), class attendance ($r = .40$) and average homework grade ($r = .60$). Regarding the latter, many students periodically failed to hand in homework and/or to check the answers in the back of the book. Other variables did not correlate significantly with the average examination score. The pretest was also related to students' attendance ($r = .32$), and negatively to their reported amount of time studying ($r = -.38$). The number of problems completed in tutoring sessions 2 and 4 ($n = 27$) was related to the pretest ($r = .48$), average examination score ($r = .45$), and negatively to the number of study hours intended ($r = -.43$). A multiple regression containing all the above mentioned variables showed that the pretest and average homework grade accounted for 64% of the variation ($r2$) in average examination scores.

Comparison of High and Low Examination Performers. In the first tutoring session, for the best students 34% of their thoughts were passive, 24% reflected uncertainty, and 44% were coded as active. For the worst students 42% were passive, 26% were uncertain, and 29% were active. Given the small number of students in each category these

differences did not reach statistical significance (t tests). For the second tutoring session--problem solving--the best students tended to have a greater understanding of frequency distributions and formulas than the worst students. But overall, there were no significant differences between the two groups.

Discussion

As other studies have shown, e.g., Feinberg and Halperin (1978), Watson (1988), mathematical and arithmetical ability was related to how well students performed on statistics examinations. What is new in our results is the demonstrated importance of some motivational components such as doing homework diligently. The multiple r^2 of .64 for these two measures is surprisingly high, and should be replicated in research at other locations. Assuming the reliability of this finding, and of the implied causal relations, most of the mystery of poor statistics performance is solved. We can vastly improve the average performance in our psychological statistics courses by including only those who have adequate prior ability in mathematics and who will do the practice work required during the course. Of course we will likely also markedly reduce enrollments by taking these steps.

The results also suggest that previous mathematics ability may have motivational effects. Students with higher mathematical ability attend class more often, spend less time doing homework, and work more quickly and accurately than students with low ability. Being engaged

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with the material isn't a chore for the former group, but seems to be for the latter students.

The failure to find significant differences in thought processes between the best and worst students is different than the results of the Chi et al., (1989) and Allwood (1984) studies, although the trends were similar. One possible explanation for our results is that good performance in introductory statistics can be achieved with relatively unsophisticated modes of thinking. Thus, good and poor performers likely process new material in similar ways.

If our results can be generalized to other academic settings, then the practical implications are relatively straightforward--require of our students certain minimal knowledge levels and diligent homework practices, e.g., don't accept less than perfect homework. However, owing to the possibility that our results may be either idiosyncratic or merely correlational, a larger field study would be justified. In this experiment students would be taught to criterion statistic relevant arithmetic and algebra before being allowed to enroll in the course. Once enrolled, their homework and practice work would be closely supervised. Both the academic and emotional gains for our students in such a study might be appreciable.

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